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A Flipper Band for Individual Identification of Beluga Whales (*Delphinapterus leucas*)

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Central and Arctic Region
Department of Fisheries and Oceans
Winnipeg, Manitoba R3T 2N6

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A FLIPPER BAND FOR INDIVIDUAL IDENTIFICATION OF BELUGA WHALES (Delphinapterus leucas)

by

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ABSTRACT

Orr, J. R., and M Hiatt-Saif. 1992. A flipper band for individual identification of beluga whales (Delphinapterus leucas). Can.Tech. Rep. Fish. Aquat. Sci. 1856: iv + 9 p.

Experimental banding of captive beluga whales (Delphinapterus leucas) took place in a holding pool at Churchill, Manitoba, during a four day period and at the New York Aquarium, New York, over a four year period. Bands were constructed with a type of polyurethane tubing, having both round and flattened cross sections. The point of attachment was the base or wrist of the pectoral flipper. Observations were made to determine which size and shape would be most compatible for long term banding. Thirteen bands (2 round, 11 flattened) of various circumferences were worn from 3 to 488 days. Bands were removed as a result of improper fit, trauma to the skin and material deterioration. Of the shapes and sizes tested, flattened bands with an outside diameter of 6.8 millimetres and circumference within -7 to +26 millimetres of pectoral wrist circumference usually stayed on the longest. Bands of this type, treated with an ultraviolet retardant, could last an average of two years and possibly as long as four years on the whales held at the New York Aquarium. To be banded, free ranging beluga would have to be captured and handled briefly to ensure a proper fit. These bands could be used in mark-recapture programs, to identify beluga whales taken during aboriginal subsistence hunts.

Key words: marine mammals; banding; marking; white whale; tagging; recapture.

RÉSUMÉ

Orr, J. R., and M Hiatt-Saif. 1992. A flipper band for individual identification of beluga whales (Delphinapterus leucas). Can.Tech. Rep. Fish. Aquat. Sci. 1856: iv + 9 p.

On a effectué des expériences de marquage avec «bracelets» sur des bélugas (Delphinapterus leucas) captifs pendant quatre jours dans un bassin de Churchill, Manitoba, et pendant quatre ans à l'Aquarium de New York. Les bracelets étaient faits à partir d'un tube de polyuréthane, rond dans certains cas et aplati dans d'autres. Le bracelet était posé à la base, ou «poignet», de la nageoire pectorale. Le but des expériences était de déterminer la taille et la forme de bracelet qui conviendraient le mieux pour le marquage à long terme. Treize bracelets (deux ronds et onze plats) de circonférences différentes ont été portés pendant une période variant de trois à 488 jours. Les bracelets étaient enlevés lorsqu'ils n'étaient pas de la bonne taille, lorsqu'ils causaient des lésions cutanées ou lorsqu'ils étaient détériorés. Des différentes formes et tailles testées, les bracelets aplatis de diamètre externe de 6,8 mm et dont la circonférence se situait entre -7mm et +26mm par rapport à la circonférence de la nageoire pectorale restaient habituellement en place le plus longtemps. Une fois traités pour résister aux ultra-violets, des bracelets de ce genre pourraient durer en moyenne deux ans en peut-être même jusqu'à quatre ans chez les bélugas de l'Aquarium de New York. Pour marquer des bélugas vivant en liberté, il faudrait les capturer et les garder captif pendant un court laps de temps pour s'assurer que les bracelets sont de la bonne taille. Les bracelets pourraient servir dans le cadre des programmes de marquage-recapture, pour identifier les bélugas capturés par suite de la chasse de subsistance pratiquée par les autochtones.

Mot-clefs: mammifères marins; bracelet, béluga; marquage; recapture.

INTRODUCTION

To effectively manage stocks that are harvested, one must fully understand the life history of the species. Gathering information on an individual's seasonal movements is one of the many important aspects required in achieving this goal. Beluga whales (Delphinapterus leucas) are highly mobile and may travel hundreds of kilometers between their wintering and summering areas (Richard et al. 1990). Accurate identification of individual beluga whales, from place to place and from one year to the next is a difficult task. Certain whale species have color patterns, scars or tail shapes that make individuals unique. Beluga whales have uniform color patterns and body shapes, making positive identification of individuals extremely difficult. In certain parts of the Canadian Arctic scarring occurs as a result of bullet wounds sustained during aboriginal hunting (Richard and Orr 1986). This can be used as an identifier (Smith et al. 1990), but observational bias and changes in the shape through healing, make this method unreliable between observers and from one year to the next. Although difficult to accomplish, it appears that marking beluga with man-made devices would be the most dependable method for positive identification of individuals.

A wide variety of visual tags and artificial marks have been applied to whales and dolphins (White et al. 1981; Geraci and Smith 1990) but none were considered effective for long term marking of beluga whales. Sergeant and Brodie (1969) tagged several hundred beluga in western Hudson Bay over a two year period in the mid-sixties, using 700 harpoon (spaghetti) and 118 Petersen type disc tags. Of these, just three harpoon tags were recovered. Spaghetti tags, dorsal implants, tatooing and freeze branding were recently tested on captive beluga, but none were considered successful as long-term identifiers (Geraci and Smith 1990). Infection, tag movement and epidermis thickness were the three main reasons for tag failure during their study. Our objective was to test a band-style tag which would be less susceptible to those problems; something resilient enough to endure the marine environment, yet unobtrusive enough not to affect the streamlined form of the whales' body.

The pectoral flippers of beluga, like those of other whales, are used primarily for balance, steering and braking, but not for propulsion (Kleinenberg et al. 1964). Also, the pectoral flippers are relatively broad, increasing in width soon after the junction with the body. We considered the "wrist", as a good location to accommodate a band. The "wrist" is defined as the narrow stock between the broad surface of the pectoral flipper and the body (Fig. 1).

Our tests involved a non-invasive mark, using a type of polyurethane tubing previously used as a streamer on a spaghetti tag (Geraci and Smith 1990). We present information collected from both short term experiments in a holding pool near the Churchill River, Manitoba, Canada and results from longer term studies on whales at the New York Aquarium, New York, USA.

METHODS AND MATERIALS

BAND CONSTRUCTION

To construct the bands we initially chose a "class EG-80A" polyurethane tubing (Tecoflex TM, Thermetics Inc., Mass) with a 4.3 millimetre (mm) outside diameter (o.d.) and a 3.6 mm inside diameter (i.d.). To form the band a liquid adhesive called Tetra Hydrafuran (THF) solvent was used to bond a butt joint, reinforced with a 3.6 mm o.d., 10 mm long insert (Fig. 2). The loop was then placed in a drying tray in such a way that the joint area would maintain the same shape as the rest of the tubing. Additional THF solvent was applied with a cotton swab to ensure the joint had proper adherence.

Flattened bands were constructed in a similar fashion. Tube size was increased to 4.3 mm i.d. and 5.1 mm o.d. and the insert size was increased to 4.3 o.d.. The tubing was flattened by placing it between two pieces of plywood with 13 kg of lead on top and warming it for 1.5 hours at 65°C. Once the tubing was flattened its width was approximately 6.8 mm.

Similarly, one flattened band was made twice as long as the required circumference, twisted to form two loops when applied to the flipper. The intention with this style of band was to determine whether one of the loops would stay tight while the other remained loose. If so, a larger band could be placed on the whale without falling off, accommodating more flipper growth than a single looped band.

Data on flipper wrist size initially came from beluga taken during Inuit hunts at various locations in the Canadian Arctic (R. Stewart, DFO, Winnipeg, Man., personal communication) and later from the actual measurements of captive whales at the New York Aquarium. Flipper circumference was determined by wrapping a piece of string around the whale's wrist and measuring its length.

BAND APPLICATION

Short-term: Churchill River

Round bands were fitted onto the left wrist of three temporarily restrained wild beluga during live captures for aquaria at the Churchill River in July of 1987, to determine whether the bands would fit onto and be tolerated by the whales. The bands were removed after a few minutes of observation, before the

whales were released. Bands were also tested for four days at the Churchill River during beluga live captures in July of 1988. During the latter study, four young beluga (one male, three females) were kept in a holding pool (4 m x 5 m x 2.5 m) for other research studies. During this time different-sized flattened bands were placed on the whales. The pools were drained and refilled during every high tide. When the water level was lowered, closer examinations of the flippers and bands were made.

Long-term: New York Aquarium

Long-term effects of the bands were tested on four whales held at the New York Aquarium. This on-going study was initiated on 19 October 1987. The bands were placed on four whales during routine medical examinations or during transfers between pools. The whales were housed in one of three different pools, depending on the time of year and their exhibit status. The maximum depth of the pools was 3.35 m. The smallest pool was 8.84 m in diameter. The largest pool was 28.7 m long by 6.6 m wide at one end and 13.0 m wide at the other. Water conditons in all three pools throughout the year were: temperature 10.0°C, salinity 28.0 parts per thousand, dissolved oxygen 8.8 parts per million and pH 7.7.

Once a band was applied and the whale was released, observations were made for several minutes to determine if any abnormal behavior was displayed. Closer examination of the flipper was done opportunistically and if modification in behavior or any sign of trauma to the skin in the banded area was observed the band was to be removed immediately. Observations and results were routinely discussed with veterinary staff.

To reduce handling time the whales were trained, through the use of operant conditioning, to turn on their side perpendicular to their trainer and present their flipper. Once in this position the whales allowed manipulation of the flipper and handling of all parts except the posterior edge. If handled in this area, the beluga would usually pull the flipper away or break station entirely. This was true with all the beluga in the aquarium whether they were banded or not. Consequently, this area was inspected last and usually just visually. The inspection of the flipper and brief description of the study was incorporated into the daily educational demonstrations, when banded whales were in pools accessible to the public.

RESULTS

Short-term: Churchill River

During the 1988 Churchill River study the whales were fitted with a range of band sizes. The whales' wrist sizes could not be measured, but their total lengths were 225 cm, 275 cm, 290 cm and 340 cm, and band sizes were 324 mm, 337 mm, 318 mm and 330 mm, respectively, or 14.4%, 12.3%, 11.0% and 9.7% of the whales' total length. It was observed that the wild beluga moved their flippers rapidly as they attempted to swim around as a group in the holding pool. On day two of the study the bands that were 14.4% and 12.3% of total length were found floating in the pool and were replaced on the respective whales the next time the water level was lowered. After these bands were replaced, all the bands remained on the whales for the duration of the study. Observations revealed that all the bands tended to migrate down the leading edge of the flipper from time to time. On day four, when the water was drained, the flippers were examined and the bands were removed. All the whales had noticable impressions, approximately 7 mm wide and 2 mm deep, on the leading edge of the flipper but there were no signs of cuts or abrasions.

Long-term: New York Aquarium

On 19 October 1987, whales 1 and 2 were each fitted with one round band on their left flipper (Table 1). The band on whale 1 was equal to its flipper circumference and the band on whale 2 was 12 mm greater. Seventy-one days later whale 2 showed signs of band-induced abrasion on the leading edge of its flipper, approximately 5 cm from the point where the flipper meets the body. The bands were immediately removed from whales 1 and 2 even though the former showed no sign of physical trauma. When the same round band was put back on whale 1, 144 days after removal, it wore the band for an additional 119 days, at which time the band was removed because it had begun to deteriorate (Table 1). The whale's flipper did not appear to be injured or irritated but there was a slight depression area, not sensitive to the touch, where the band had been.

This depressed area on the leading area of the flippers was caused by pressure from the band, which compressed the skin. Since the flippers returned to their original shape when the band was removed, it was concluded that the integrity of the skin was not affected. (R. A. Cook, Chief Veterinarian, New York Zoological Society, New York, USA, personal communication)

The double-looped band applied to whale 4 was removed after three days. One of the loops did remain tight but because of the fluttering and lateral movement of the loose loop the band appeared uncomfortable. No cuts or abrasions were observed on the flipper when the band was removed.

Ten flattened single looped bands of various sizes were worn from 27 to 488 days (Table 1). Decisions for removal of the bands were based on: the band appearing to cause discomfort (30 days, N=1), band-induced cuts and abrasions (27 to 219 days, N=3) and the deterioration of the band material (87 to 488 days, N=6). The most injurious cut was observed on whale 2, which wore a flattened band 32 mm smaller in circumference than its wrist. A series of three cuts appeared on the posterior edge of the flipper, 25 mm to 70 mm from the junction of the body. Two of the cuts had healed by the time the band was removed, leaving two small indentations on the flipper. The third cut, which was closest to the body, was healing around the band. The wound was approximately 8 mm wide and 9 mm deep but there was no sign of infection or bleeding. After the band was removed antibiotic ointment was administered and it healed quickly, leaving a rippled area 45 mm long. The other cuts and/or abrasions that were discovered on the other whales were superficial and healed quickly after the band was removed. (R. A. Cook, Chief Veterinarian, New York Zoological Society, New York, USA, personal communication).

When the whales were engaged in straight line forward movement they usually swam with the tips of their flippers pointed posteriorly. Because of this the bands, especially the larger sizes, slipped down the leading edge of the flipper and became wedged in that position. This event usually created a depression and, on a few occasions, a cut in the skin on the leading edge of the flipper or on the posterior edge, near the body.

Two of the whales under 3 m in length and fitted with bands 12.3% and 14.4% of body length, initially shed the bands while in the holding pool at Churchill River. The whales at the New York Aquarium were all over 3 m in length and the largest band put on them was 14.3% of body length. This band didn't fall off but was removed within a month, as well as a band that was 13.4%, because both appeared to be unsuitably large. Of the eight flattened bands 10.1% to 11.4% of body length, placed on these whales, two had to be removed due to signs of skin irritation while the other six remained on until the band deteriorated (Table 2).

DISCUSSION

ROUND VS FLATTENED BANDS

Flattened bands appeared to move around less than round bands, but with both types of bands there was a substantial amount of movement when circumference exceeded the wrist by more than 26 mm. The change from round to flattened bands was done to reduce the amount of lateral rolling movement of the band along the leading edge of the flipper and to increase the surface area of the band. This change reduced movement somewhat but band movement was related more to band size than band shape.

BAND SIZE - WRIST SIZE

Our results indicate that a band is too small when its circumference is in the range of -32 mm and -8 mm of wrist circumference. A band becomes too large soon after its circumference is greater than 26 mm of the wrist. The band that stayed on for the longest duration had a circumference 7 mm less than wrist circumference. It should be noted that there was enough slack in this band that a finger could be easily slipped between the band and flipper on the leading edge without noticably stretching the tubing. The only other band that was smaller than -7 mm (-32 mm) caused the most serious wound to the wrist. Bands that were within -7 mm to +26 mm of wrist circumference usually stayed in place until the material deteriorated. Therefore, to ensure a proper fit of bands it is necessary to get a relatively accurate wrist measurement of the wrist circumference before application. Ideally, obtaining the actual measurement would be best, but this may not always be possible during beluga live captures and temporary restraints, considering the strength of these animals and the conditions under which they may have to be handled.

BODY SIZE - WRIST SIZE RATIO

If a whale's wrist circumference can't be measured, an approximate circumference can be estimated from total length. Kleinenberg et al. (1964), like most others, had little information on flipper wrist circumference, but the data did show that, although length of the pectoral flipper relative to body length decreased with age, the width of the pectoral flipper increased in constant proportion to body length. Data collected in western Hudson Bay (R. Stewart, DFO, Winnipeg, Man., personal communication) showed that wrist circumference of whales under 3 m in length, or less than seven years of age, ranged from 11.6% to 12.5% of body length with a mean of 12.0%. Wrist circumference of those 3-4 m in length, or older than seven years of age, ranged from 9.9% to 11.7% of body length with a mean of 10.5%. This suggests

that as a whale matures the ratio of wrist circumference-to-body-length decreases. All wrist circumference measurements from the whales held at the New York Aquarium were within this range (Table 2).

Growth in beluga begins to slow after about the seventh year in all stocks (Burns and Seaman 1986; Brodie 1971; R. Stewart, DFO, Winnipeg, Man., personal communication). Length-at-age varies, depending on the stock, but generally whales over seven years of age range in length between 3 and 4 m. The maximum length varies between different stocks, with Greenland whales being the largest and Hudson Bay whales the smallest. This suggests that not only does the body to wrist size ratio decrease in whales over 3 m in length, but so does the over all growth of the whale. Therefore, whales under 3 m would require a band with the maximum amount of oversizing to compensate for growth, while whales over 3 m would be fitted with a band closer to their flipper size.

BAND LONGEVITY

The Tecoflex tubing eventually breaks down when subjected to ultraviolet radiation (D. Brown, Thermetics Inc., Woburn, Mass., personal communication). During our study on captive whales held at the New York Aquarium, the first sign of band deterioration was a color change from clear to milky white. The elasticity of the band decreased to a point where it took several seconds to return to its original size when stretched, as compared to an instantaneous response when new. Next, the edges began to fray and small fragments of the material began to slough off. Eventually the band became yellow in color and lost its elasticity completely. Of the six bands that deteriorated, two were left until they fell off, the other four were taken off before the band came apart. There was no sign of trauma to the skin caused by the deterioration of the band.

The length of time it takes for the material to deteriorate depends on the amount and intensity of ultraviolet radiation that it absorbs. The bands on the whales held at the New York Aquarium were subjected to sunlight at approximately 41°00 latitude, in clear water, less than 3.35 m below the surface. Under these conditions the material deteriorated after an average of 242 days (N=6) (Table 1). Free ranging beluga would presumably be swimming part of the time in deeper, and at times more turbid water, and for a large part of the year under ice. This would reduce the total annual exposure to ultraviolet radiation. Also, although there are slightly more hours of annual solar radiation at latitudes above 60°00 as compared to 41°00 (List 1966), the sun angle is shallower, reducing light penetration into the water. In general, free ranging whales are expected to be subjected to less ultraviolet radiation than the captive whales at the New York Aquarium and bands applied to beluga in the wild would be expected to last longer.

Ideally, a band should stay on a whale for at least one year, so that the whale can potentially be recaptured thoughout its entire migratory cycle. The use of untreated tubing may not provide a sufficient window of time. However, the durability of Tecoflex can be increased by adding an ultraviolet stabilizer during resin formulation (D. Brown, Thermetics Inc., Woburn, Mass., personal communication). This would extend the life of the tubing up to three times, or to an average of 726 days (two years) and up to four years at the New York Aquarium. If the lifespan of a band on a free-ranging beluga is increased by using a ultraviolet stabalizer, it would extend the window of time available for recapture.

SUMMARY AND RECOMMENDATIONS

Our study suggests that a flattened band within -7 mm to +26 mm of wrist circumference is the acceptable type and size to use on beluga whales. With this in mind, whales over 3 m in length should be fitted with relatively snug bands and whales under 3 m in length should be fitted with loose bands (26 mm larger than wrist circumference) to allow for growth. Whale body length should be used as an indication of proper band size when the actual measurement of wrist circumference is not possible.

The band described in this report is only useful for mark-recapture studies where the whales could be closely examined at time of recapture, because it is difficult to see a clear-colored band on a swimming whale. Although various colors are available, using a clear colored band reduces hunter bias towards a banded versus unbanded animal. Bands could be distingiushed from each other by using small, flexible, numbered inserts, placed inside the tube before it is formed into a loop. The participation of native subsistance harvesters is critical to the success of a banding program. Therefore, hunter information programs would be necessary in areas where banded whales could be harvested. Information seminars and posters should be used in the hunting communities and a sufficient reward should be promised as an incentive for a high return of bands.

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REFERENCES

BRODIE, P.F. 1971. A reconsideration of aspects of growth, reproduction, and behavior of the white whale (Delphinapterus leucas) with reference to the Cumberland Sound, Baffin Island population. J. Fish. Res. Board Can. 28: 1309-1318.

BURNS, J.J., and G.A. SEAMAN. 1986. Investigations of belukha whales in coastal waters of western and northern Alaska. Part II. Biology and Ecology. U.S. Dep. Commerce, NOAA, OCSEAP Final Rep. 56: 221-357.

GERACI, J.R., and G.J.D. SMITH. 1990. Cutaneous responses to implants, tags, and marks in beluga whales (Delphinapterus leucas) and bottlenose dolphins (Tursiops truncatus), p. 81-95. In T. G. Smith, D. J. St. Aubin and J. R. Geraci (ed.) Advances in research on the beluga whale, (Delphinapterus leucas). Can. Bull. Fish. Aquat. Sci. 224.

KLEINENBERG, S.E., A.V. YABLOKOV, B.M. BEL'KOVICH, and M.N. TARASEVICH. 1964. Beluga (Delphinaperus leucas): investigation of the species. Israel Program for Scientific Translations No. ,1969. vi + 375 p.

LIST, R.J. 1966. Smithsonian meteorological tables. Smithson. Misc. Collect. 4 Sec. X: 411-521.

SERGEANT, D. E., and P. F. BRODIE. 1969. Tagging white whales (Delphinapterus leucas) in the Canadian Arctic. J. Fish. Res. Board Can. 26: 2201-2205.

SMITH, T. G., D. J. St. AUBIN, and J. R. GERACI. 1990. Advances in research on beluga whales (Delphinapterus leucas): introduction and overview, p 1-6. In T. G. Smith, D. J. St. Aubin and J. R. Geraci (ed.) Advances in research on the beluga whale (Delphinapterus leucas). Can. Bull. Fish. Aquat. Sci. 224.

RICHARD, P. R., and J. R. ORR. 1986. A review of the status and harvest of white whales (Delphinapterus leucas) in the Cumberland Sound area, Baffin Island. Can. Tech. Rep. Fish. Aquat. Sci. 1447: iv + 25 p.

RICHARD, P. R., J. R. ORR, and D. G. BARBER. 1990. The distribution and abundance of belugas (Delphinapterus leucas), in eastern Canadian subarctic waters: a review and update, p. 23-38. In T. G. Smith, D. J. St. Aubin and J. R. Geraci (ed.) Advances in research on the beluga whale (Delphinapterus leucas) Can. Bull. Fish. Aquat. Sci. 224.

WHITE, M.J., J.G. JENNINGS, W.F. GANDY, and L.H. CORNELL. 1981. An evaluation of tagging, marking, and tattooing techniques for small delphinids. U. S. Natl Oceanic Atmos. Adm. Tech. Memo. 142 p.

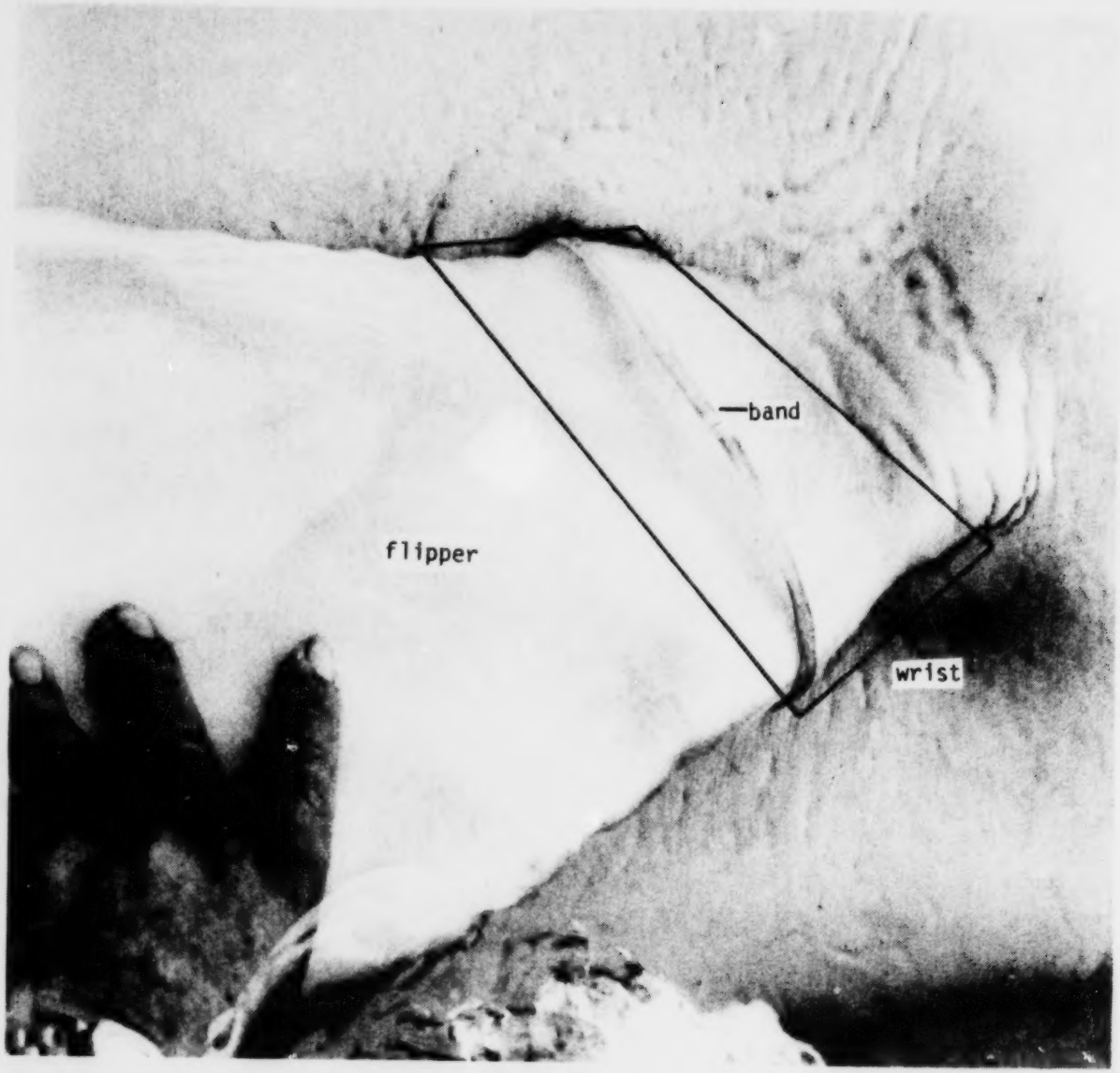

Fig. 1. Flipper presentation of a whale at the New York Aquarium, showing the right pectoral flpper, its wrist and a flattened band. By Rick Miller

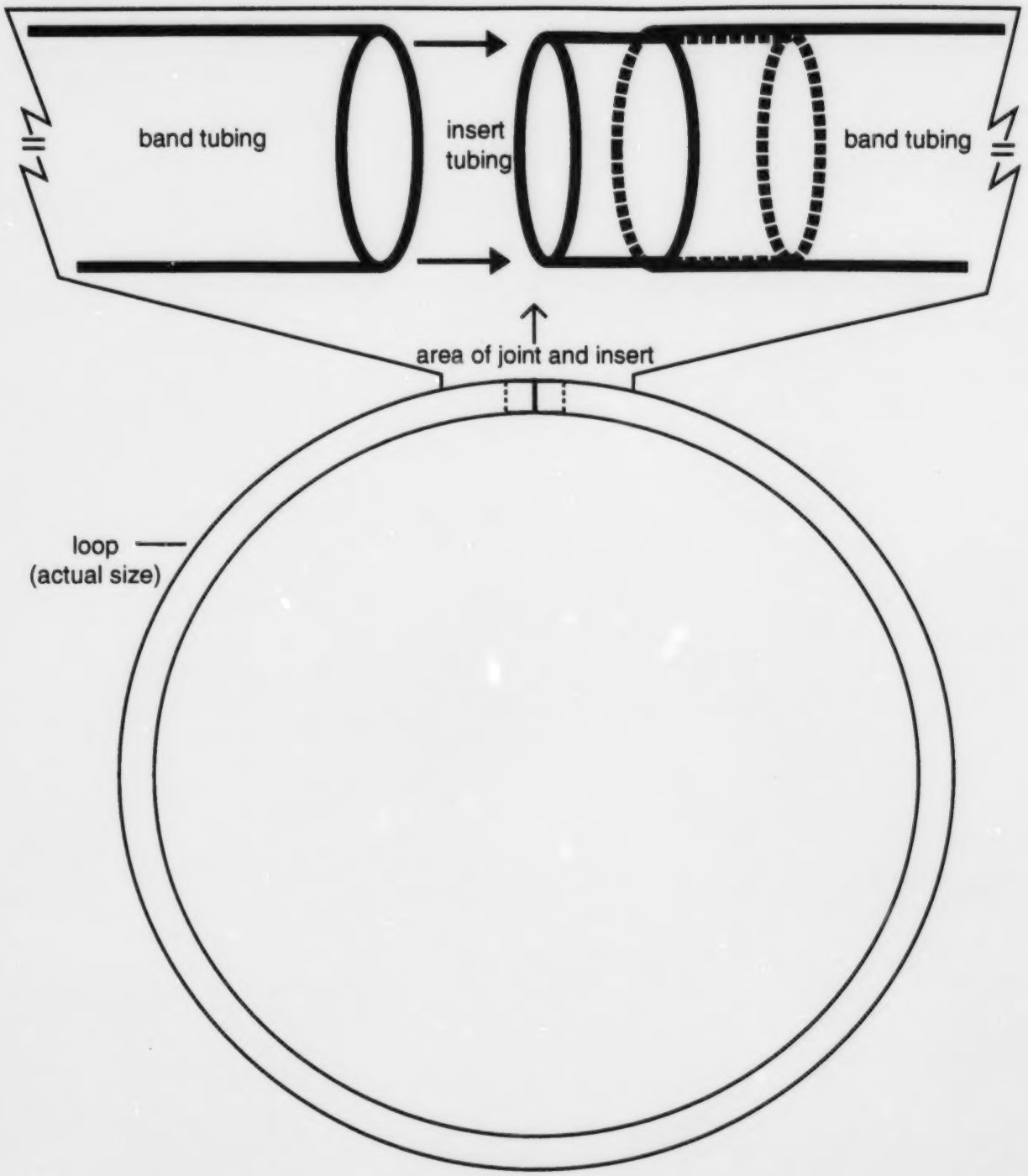

Fig. 2 . Forming of the tubing into a flipper band, showing the jointed area.

Table 1. Types and sizes of bands worn by beluga whales at the New York Aquarium, the number of days each band was worn, from shortest to longest and reasons for band removal.

Whale I.D.	Wrist Circumference (mm)	Band Circumference (mm)	Band Circumference vs Wrist Circumference (mm)	Days on Whale	Reason for Removal
		Round	Bands		
1	343 L[1]	343	0	71	Whale 2 showed abrasion
2	356 L	368	12	71	Showed abrasion
1	343 L	343	0	119	Band deteriorated
		Flattened	Bands		
4	343 R[2]	864[3]	89	3	Appeared uncomfortable
4	343 R	432	89	27	Showed abrasion
4	343 L	406	63	30	Band appeared too large
2	375 R	343	-32	69	Cut on posterior edge
3	361 L	368	7	219	Cut on anterior edge
3	337 R	361	20	89	Band deteriorated
3	362 L	381	19	123	Band deteriorated
3	361 L	361	0	152	Band deteriorated
3	330 L	356	26	294	Band deteriorated
3	330 R	343	13	303	Band deteriorated
3	362 R	356	-7	488	Band deteriorated

[1]Left
[2]Right
[3]Double Loop

Table 2. A comparison of wrist and band circumference to body length of beluga whales studied at the New York Aquarium. Size of band in relation to wrist size is compared with residence time of band and reason for removal.

Whale I.D.	Whale Body Length (cm)	Wrist Circumference (mm)	% of Wrist to Body	% of Band to Body	Difference between Band and Wrist Circumference	Days on Whale	Reason for Removal
			Round	Bands			
1	323	343 L[1]	10.6	10.6	0	71	Band on whale OK, removed because whale 2 showed abrasion
1	323	343 L	10.6	10.6	0	119	Band deteriorated
2	323	356 L	11.0	11.4	12	71	Showed abrasion
			Flattened	Bands			
2	338	375 R[2]	11.1	10.1	-32	69	Cut on posterior edge
3	333	362 R	10.8	10.6	-7	488	Band deteriorated
3	337	361 L	10.7	10.7	0	152	Band deteriorated
3	337	361 L	10.7	10.9	7	219	Cut on anterior edge
3	310	330 R	10.6	11.1	13	303	Band deteriorated
3	333	362 L	10.8	11.4	19	123	Band deteriorated
3	337	361 L	10.7	11.3	20	89	Band deteriorated
3	310	330 L	10.6	10.6	26	294	Band deteriorated
4	302	343 L	11.3	13.4	63	30	Band appeared too large
4	302	343 R	11.3	14.3	89[3]	3	Appeared uncomfortable
4	302	343 R	11.3	14.3	89	27	Showed abrasion

[1]Left
[2]Right
[3]Double Looped